Benha University		**Time: three hours.**
Faculty of Science		**First Semester 2018-2019**
Dept. Of Geology		**Date: 10/1/2019**

Advanced well logging (687G) for Pre-master Students (Applied Geophysics)

جامعة بنها – كلية العلوم – قسم الجيولوجيا

دراسات عليا(تمهيدى جيوفيزياء تطبيقيه)

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الممتحن: د/ وفاء الشحات عفيفى الشحات

أستاذ مساعد بقسم الجيولوجيا بكلية العلوم

الاسئله ونموذج الاجابه

ورقه كامله

Benha University

Faculty of Science

Dept. Of Geology

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Answer four of the following questions *including the first question*:

Question1. (30Marks)

Write on four of the following:

- a- Quick look interpretation
- b- Error analysis
- c- Nuclear Magnetic Resonance logging
- d- Fuzzy logic
- e- Fluid replacement modelling (Rock physics modelling)

Question2. (30Marks)

- a- What are the three classifications of trap?
- b- Write about exploration methods

Question3. (30Marks)

Discuss the following:

- a- The types of information you can obtain from core analysis
- b- Types of wells

Question 4. (30 Marks)

- a- What are the functions of blow out preventers and the mud fluid?
- b- List the types of drilling fluids

Question 5. (30 Marks)

- a- List the important information you would get from running well logging?
- b- Write briefly about well control system and its types.

BEST WISHES

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<u>Answer of Question1. (30Marks)</u>

Write on four only of the following:

a- Quick look interpretation

Once the section TD (total depth) of the hole has been reached, the petrophysicis will be expected to make an interpretation of the open hole logs that have been acquired. Before starting the log interpretation, the petrophysicist should have:

1. All the relevant daily drilling reports, including the latest deviation data from the well, last casing depth, and mud data
2. All the latest mud-log information, including cuttings description, shows, gas reading, and ROP (rate of penetration)
3. Logs and interpretations on hand from nearby wells and regional wells penetrating the same formations, in particular where regional or field wide values of *m*, *n*, *Rw*, rho*g* and fluid contacts are available
4. A copy of the contractor's chart book

b- Error analysis

In an ideal world, the net/gross, porosity, and saturation would be accurately known in all parts of the reservoir. In practice, one is trying to determine the properties based on measurements performed in a number of wells in the field, each subject to measurement error. Hence it is important to realize that there are two completely different and independent sources of error in petrophysical properties across a field. Firstly, there are errors arising from tool accuracy, sampling, and the petrophysical model, which will affect zone averages as measured in individual wells.

Secondly, there are errors arising from the fact that these properties are only "sampled" at discrete points in the field. Whether or not properties such as porosity and net/gross are mapped over the structure, or if the well data are used to make an estimate of the mean values, the result is uncertainty which in some cases can be huge.

We will first deal with errors in the zonal average properties as measured in a particular well. I believe the most rigorous way of dealing with measurement error is through the use of Monte Carlo analysis. This method has the advantage of not requiring any difficult mathematics and is easily implemented in a spreadsheet.

c- Nuclear Magnetic Resonance logging

NMR logging attracted a lot of interest because it was a whole new type of measurement and offered the possibility of direct measurement of porosity and the differentiation of fluid types and the relative contributions arising from clay-bound water from free water. The basic principle by which the tool operates is as follows. The tool is assumed to respond only to hydrogen nuclei (in water, oil, and gas) in the pore space. The hydrogen nuclei (which are just protons) in the pore fluids have a spin and magnetic moment that may be affected by an external magnetic field. In the absence of an atomic field, these moments are aligned randomly. When an external field (*B*0) is applied, a process occurs whereby the orientation of the nuclei changes so that a proportion of them align in the direction of the applied field *H*.

d- Fuzzy logic

“Fuzzy logic” is a technique that assists in facies discrimination, and that may have particular application in tying together petrophysical and seismic data. In this chapter, the basic technique will be explained together with a worked example to illustrate the principle. Consider a situation in which one is using a GR (gamma ray) log to discriminate sand and shale. With the conventional approach, one would determine a cutoff value below which the lithology should be set to sand and above which it should be set to shale. To use fuzzy logic, one would do the following:

1. In some section of the well where sand and shale can be identified with complete confidence, one would generate a “learning set,” that is, create a new log in which the values are set to 0 or 1 depending on whether the formation is sand or shale.
2. Over the interval defined by the learning set, one would separate all the bits of GR log corresponding to sand and shale, respectively.
3. For the sand facies, a histogram would be made of all the individual GR readings. To this distribution would be fitted a mathematical function (most commonly a normal distribution) that would capture the mean and spread of the data points. This is often called a “membership function.”

e- Fluid replacement modelling (Rock physics modelling)

Fluid replacement is a central part of AI modelling or creating synthetic seismograms. In essence it involves predicting how the sonic or density log will change as one pore fluid replaces another. Unfortunately, the equations used to do this, developed by Gassmann, are cumbersome to apply. They also require input data that may not be readily available.

<u>Answer of Question2. (30Marks)</u>

a- What are the three classifications of trap?

1. Structural traps; they are formed because of deformations in the rock such as a fault or anticline
2. Stratigraphic traps are formed when other beds seal the reservoir bed or permeability changes within the reservoir bed Stratigraphic traps can be extremely varied
3. Combination traps they have both structural and stratigraphic attributes

c- Write about exploration methods

-Exploration methods such as remote sensing and the mapping of rock outcrops and seeps can obtain indications of the presence of oil and gas called **(Geologic Surveys).**

-Geologic (Surveys)

Geological surveys normally are a casual use. Rock outcrops and topography are examined to determine the structural attitude and age of the surface formations, and surface maps are prepared. In many cases indirect methods, such as seismic, gravity, and magnetic surveys are used to delineate subsurface features that may contain oil and gas called **(Geophysical Surveys)**.

Geophysical surveys

• Gravity surveys The gravity method measures small changes in the earth’s gravity field caused by density contrasts between disparate rock types. In the case shown here, the density of the salt diapir is sufficiently different than the surrounding sedimentary clastic section to be detected by the gravity tool. The sensing element in the tool is a sophisticated form of spring balance. Variations in the earth’s gravity field cause changes in the length of the spring, which are measured. Measurements must be corrected for the elevation of the recording station.

• Magnetic surveys. The magnetic method is a very popular and inexpensive approach for near-surface metal detection. Engineering and environmental site characterization projects

often begin with a magnetometer survey as a means of rapidly providing a layer of information on where utilities and other buried concerns are located
• Seismic surveys

<u>Answer of Question3. (30Marks)</u>

Discuss the following:

a- The types of information you can obtain from core analysis

1. Core analysis makes it possible to recognize the structure of the reservoir trap,
2. Determine its physical properties such as porosity, permeability, estimates production capability of wells.
3. Core data allows wells to be properly completed by selecting intervals of DST and evaluating the effectiveness of completion

b- Types of Wells

1- Exploratory wells

– Commonly called wildcat
– Drilled to find out if petroleum is present
– Drilling in an unknown environment
– Cost more and requires better planning

2- Development wells

– Once a reservoir is determined to be economically viable, multiple wells are drilled to develop the reservoir
– When reducing the acreage per well, they are called infill wells
– Wells near the boundary are called step-out wells

3- Injection wells

The use of water-flooding or gas injection to maintain formation pressure during primary production and to reduce the rate of decline of the original reservoir drive.

<u>Answer of Question 4. (30 Marks)</u>

a- What are the functions of blow out preventers and the mud fluid?

Blow Out Preventers One or more valves installed at the wellhead to prevent the escape of pressure either in the annular space between the casing and the drill pipe or in open hole (for example, hole with no drill pipe) during drilling or completion operations.

Functions of Drilling Mud

Cleaning the hole, • Cooling and lubricating the bit and drill string, • Lifting cuttings to the surface, • Control the formation pressure, • Stabilizing the well bore, • Carrying information about Formations

b- List the types of drilling fluids

Type of Drilling fluid

Water Base Mud Water is the liquid phase of mud -Clay for viscosity, -Barite for density, -Chemical to get desired properties, -Drill solids as a contaminant

Oil Base Mud

Oil is the liquid phase of mud, Usually and oil water mixture, The water is emulsified in the oil producing viscosity, Can use crude oil, diesel, mineral oil or synthetic oils, Mineral oils and synthetic oils are more environmentally friendly but expensive

<u>Answer of Question 5. (30 Marks)</u>

a) List the important information you would get from running well logging? (15 Marks)

Well logs provides:

1. Lithology-2. Oil saturation- 3. Bed thickness- 4. Average porosity, 5. Average permeability, 6. Initial oil in place - 7. Gas oil contact - 8. Oil water contact- 9. Wellbore diameter- 10. Location of casing collar, 11.Cement bond- 12.Perforation interval

b) Write briefly about well control system and its types.

Well Control System The methods used to control a kick and prevent a well from blowing out. Such techniques include, but are not limited to, keeping the borehole completely filled with drilling mud of the proper weight or density during operations, exercising reasonable care when tripping pipe out of the hole to prevent swabbing, and keeping careful track of the amount of mud put into the hole to replace the volume of pipe removed from the hole during a trip. In conventional drilling, the pressure of the mud column in the hole is always slightly greater than the formation fluid pressure; this is known as **primary well control**. Under certain conditions, primary well control may be lost; generally when this happens, a kick (influx of formation fluid) occurs. Surface equipment, including devices known as blowout preventers, allows the safe circulation of the influx fluid and return to balance in the wellbore. Use of the blowout preventers to control a kick is known as **secondary well control.**